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National Aeronautics and
Space Administration

February 5, 1998

Subcommittee on Space and Aeronautics

Committee on Science

House of Representatives

Statement by:
Daniel S. Goldin
~~Administrator~~

105th Congress

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Mr. Chairman and Members of the Subcommittee:

I am pleased to be here to present to you NASA's budget request for FY 1999. Once again, I look back at the year that has just concluded in amazement and pride at what the NASA team has accomplished. It has been another incredible year, one in which discoveries from NASA missions filled the calendar, the front pages of our Nation's newspapers and magazines, and television screens around the world: images of rocks, nicknamed "Scooby Doo" and "Barnacle Bill," from the surface of Mars; images of the surface of Jupiter's moon Europa, suggesting the possibility of hidden, subsurface water; spectacular images from the Hubble Space Telescope of a galactic collision and the resulting birth of 1,000 bright young star clusters; the image of the El Niño weather phenomenon underway in the Pacific, combining information taken from a variety of earth observing satellites and instruments; and the image of the Space Shuttle Endeavour, lighting up the night sky, on another trip to the Mir Space Station, where U.S. and Russian astronauts are gaining experience in space operations that will prove invaluable in the assembly and operations aboard the International Space Station.

This is what NASA is all about. Our vision says it best. NASA is about exploring, about innovation, about pushing the frontiers of exploration. NASA's Strategic Plan defines this vision and poses fundamental questions of science and research that provide the reason for why we exist and the foundation for our goals. These questions are fundamental for everyone:

- How did the universe, galaxies, stars and planets form and evolve? How can our exploration of the universe and our solar system revolutionize our understanding of physics, chemistry, and biology?
- Does life in any form, however simple or complex, carbon-based or other, exist elsewhere that on planet Earth? Are there Earth-like planets beyond our solar system?

- How can we utilize the knowledge of the Sun, Earth, and other planetary bodies to develop predictive environmental, climate, natural disaster, and natural resource models to help ensure sustainable development and improve the quality of life on Earth?
- What is the fundamental role of gravity and cosmic radiation in vital biological, physical, and chemical systems in space, and how do we apply this fundamental knowledge to the establishment of permanent human presence in space to improve life on Earth?
- How can we enable revolutionary technological advances to provide air and space travel for anyone, anytime, anywhere more safely, more affordably, and with less impact on the environment and improve business opportunities and global security?
- What cutting-edge technologies, processes, and techniques and engineering capabilities must we develop to enable our research agenda in the most productive, economical, and timely manner? How can we most effectively transfer the knowledge we gain from our research and discoveries to commercial ventures in the air, in space, and on Earth?

The four NASA Strategic Enterprises encompass the programs and activities that support our goals, and are responsible for answering these fundamental questions and satisfying our customers' requirements. It is against the goals in the Strategic Plan that we measure our performance and hold ourselves accountable.

We at NASA will celebrate our 40th anniversary this year. And I am proud of the NASA team that has reinvented NASA to make it better than ever. NASA's transition over the past several years has been incredible. The amount of upheaval, uncertainty, and challenge to every aspect of the way NASA does business has touched every corner of NASA. It has been hard, incredibly hard. But the NASA team has met that challenge and emerged stronger, more flexible, for the fight. And the results are obvious. Faster, better, cheaper is not a slogan - it is routine. The FY 1994 budget included funding for 11 Space Science missions; the FY 1999 budget request contains funding for 28 missions. The original Earth Observing System envisioned a few "Battlestar Gallactica" spacecraft. The current EOS program encompasses many much smaller missions at a significantly lower cost that emphasize infusion of new technology development and responsiveness to emerging scientific discoveries while meeting all mission requirements. The NASA Aeronautics Program is at the forefront of the Administration's National Partnership in Aeronautics Research and Technology. And all the while, the size of our workforce has been reduced by 5,700 FTE since 1993, and is on target for a total complement of about 17,800 by FY 2000. We have reduced the size of Headquarters by over half in this time.

One thing has not changed - NASA's commitment to a space and aeronautics program that is balanced, relevant and stable. Let us go back two years. In the FY 1997 budget request, the outyear planning numbers were disappointing, but we knew they were not cast in stone. In 1996, the President's National Space Policy committed to stable funding for NASA. In the FY 1998 budget request, the President gave NASA a stable funding level of $13.5 billion for FY 1998 and an outyear baseline of $13.2 billion. I said at the time, the FY 1998 budget request was a vote of confidence from the President and the Administration. It was a vote of confidence that NASA had done what it needed to do -- technically, scientifically, and organizationally -- for the Nation's space and aeronautics program.

Once again, in the FY 1999 budget request, NASA has been given a vote of confidence from the President. NASA pledged to meet its commitments, and with the FY 1999 request we will continue to deliver on our promise. Total funding in the FY 1999 budget request for FY 1998 through FY 2002 represents an increase of $442 million over last year's runout. This budget is a resounding success for NASA. It also expands our horizons in two areas -- Space Science and Future Space Launch.

NASA's Space Science Program had an incredible year in 1997: the landing of the Mars Pathfinder spacecraft on the surface of Mars and exploration of the surrounding terrain by the Sojourner rover; new discoveries by the Hubble Space Telescope of over 1,000 bright, young star clusters resulting from the collision of two galaxies; and the launch of the Cassini spacecraft to Saturn and Galileo's detailed examination of Jupiter and its moons. The early pictures coming back from the Mars Global Surveyor are amazing in their depth and detail. The FY 1999 budget includes a major funding augmentation for Space Science that will continue this chain of success. These funds will support an augmentation to the Mars Surveyor Program to enhance the Mars 2001 lander, initiation of a series of Solar Terrestrial Probes to track solar phenomena and their impact on the Earth, and the initiation of mission development for the Gamma-ray Large Area Space Telescope to understand the end states of stars' lives and to seek out the most extreme environments in space. The budget also continues NASA's commitment to the search for the origins of life. In response to evidence of possible subsurface oceans discovered by the Galileo mission on Jupiter's moon Europa, we will begin planning for a mission to launch in 2003 to observe more closely potential subsurface oceans on Europa.

The second area that holds enormous potential for the future is the next generation of launch vehicles. In order to achieve significant savings in the cost of space missions, we must lower the cost of going to orbit by orders of magnitude. The Reusable Launch Vehicle (RLV) program is addressing the critical technologies needed to achieve major leaps forward to meet the challenges and lower the costs of future space missions. The X-33 and X-34 programs both successfully passed critical design tests in 1997. Funding is included in FY 1999 to continue hardware fabrication and test, in preparation for flight demonstration of both these technology demonstrators in 1999. The RLV program is a partnership between NASA and industry, built on industry-led cooperative agreements. Phase II of the X-33 program, encompassing both flight and ground tests, is underway and is expected to lead to a decision by the Government and our industry partners whether full-scale development of an RLV should be pursued. New funding is included in the NASA budget runout to support a decision at the turn of the century on what type of operational launch systems NASA should invest in that will reduce the costs of access to space.

The International Space Station program is at its most critical point. During 1997, the program focused on the continued qualification testing and manufacture of flight hardware, as the program readies for first element launch this year and subsequent flights throughout 1999. Node and Laboratory module fabrication is complete and the node and pressurized mating adapter were delivered to the Kennedy Space Center launch site. Activities are well underway to support crew training, payload processing, and hardware element processing. Our international partners have continued development of flight hardware in support of their commitments.

NASA has stated from the outset that this program was not going to be easy. The size and complexity of the International Space Station is unprecedented. Our continuing work with the Russians is providing an invaluable foundation for the assembly and construction activities of the Space Station that are now only a few months away. Despite the concerns surrounding the condition of Mir that pushed to the forefront in 1997, the experience we are gaining through our cooperation with the Russians will be instrumental to the success of this program. NASA is firmly committed to building the International Space Station on time and within cost. President Clinton has been unwavering in his commitment for the United States to continue to play a leadership role. NASA will deliver on this commitment. The Congress appropriated $230 million of the additional $430 million sought by NASA in FY 1998 to meet program requirements and maintain an adequate level of program reserves. The Administration will shortly send forward a proposal to provide the remaining $200 million for FY 1998, through appropriations transfer and reallocation within the Human Space Flight appropriation. We will work with the Congress in enacting this vital legislation.

Our highest priority continues to be the safe launch, operation, and return of the Space Shuttle and crew. Funding continues for Shuttle upgrades, including work on the Main Engine and the Orbiter. In addition, improvements to Shuttle performance, such as the Super Lightweight External Tank, remain on track. Over the next two years, Space Shuttle operations will continue the transition to a single prime contractor. In sum, the Space Shuttle team remains committed to delivering on its promise: meeting the flight rate for less money and with improved safety.

Research progress on the Mir space station, the Space Shuttle, and on the ground continued expanding our understanding of fundamental physical and biological processes while pointing the way to the most productive areas of research for the International Space Station. In addition to biomedical data, Mir research produced the first multi-generation plant experiments in space and expanded the duration of in-flight tissue culture experiments from two weeks to over four months. On the Space Shuttle, the flight and reflight of the first Microgravity Space Laboratory mission foreshadowed the flexibility and regular access our research communities will enjoy on the International Space Station. The mission yielded the first measurements of specific heat and thermal expansion of glass-forming metallic alloys, and the crew were able to sustain the weakest flames ever burned either in space or on Earth and studied the longest burning flames ever ignited in space. Combustion research in space may lead to applications that help reduce pollution and increase energy efficiency on Earth.

The Earth Science Program, formerly the Mission to Planet Earth Program, is providing valuable data right now to improve our understanding to the Earth system. Data from missions underway, including the Earth Radiation Budget Experiment (ERBE) satellite, the Upper Atmosphere Research Satellite, TOPEX/Poseidon, and SeaWIFS, as well as data from the recent NASA Scatterometer mission, is contributing to an integrated understanding of the El Niño phenomenon in the Pacific. The commercial implications of this weather condition are profound -- stretching from the commercial fishing industry to record storms and snowfalls across the nation. The Earth Observing System (EOS), the centerpiece of NASA's contribution to the U.S. Global Change Research Program, has undergone a profound transformation. As a result of this summer's Biennial Review, the program is now positioned to respond quickly to new advances in instrument technology and scientific breakthroughs, which will be complemented by a series of small, rapid development Earth System Science Pathfinder missions.

Our Aeronautics Enterprise has also performed. In the summer of 1998 over the sands of Kauai, NASA's solar-powered aircraft Pathfinder set an altitude record for propeller-driven flight of over 71,500 feet. In 1999, we will begin flights of the Centurion, which is designed to reach 100,000 feet. This type of technology will enable high-altitude, long-endurance for affordable, unpiloted science missions. The FY 1999 budget also continues our commitment to the Administration's Aviation Safety Initiative. NASA will invest $.5 billion over the next five years to develop, in partnership with industry and other Federal agencies, breakthrough technology for safer, more reliable air transportation.

This is the first budget request formulated under the requirements of the Government Performance and Results Act (GPRA). The GPRA was enacted to improve decision-making in allocating the Nation's precious tax dollars to programs. The funding requested in this budget implements the vision and mission articulated in the NASA Strategic Plan. NASA's Performance Plan, which will be submitted to Congress soon, lays out the performance measures by which the Agency will be evaluated. We expect to be held accountable for achieving our goals. Their accomplishment will not be easy, but we will deliver on our promises.

These are the highlights of NASA's FY 1999 budget request. I will now discuss the plans of NASA's Enterprises and how the FY 1999 budget request supports NASA's continuing efforts to deliver better programs for less.

Human Exploration and Development of Space

NASA's Human Exploration and Development of Space (HEDS) Enterprise includes the International Space Station, Space Shuttle, and Life and Microgravity research. HEDS seeks to bring the frontier of space fully within the sphere of human activity for research, commerce, and exploration.

Space Station

It has been five exciting and challenging years for NASA's International Space Station Program since the redesign in 1993. The dedication of our workforce has brought significant strides forward in the face of unforeseeable difficulties, and we are now moving with confidence toward First Element Launch this year. With a program managing development of state-of-the-art space technologies around the world by tens of thousands of people in 16 countries including Brazil, our accomplishments are unprecedented. On January 29, 1998, we signed the international agreements codifying this vast undertaking.

Despite the challenges still facing us, our confidence in meeting critical goals remains high. In recent months we have overcome numerous technical issues and completed many key milestones. The U.S.-owned, Russian-built Control Module, or FGB, is now on-site at the Baikonur cosmodrome launch facility, and remains on schedule, ready for launch as the first element of the International Space Station in June. The U.S. Node 1 has been delivered to Kennedy Space Center and is undergoing final preparation and checkout along with two Pressurized Mating Adapters, on target for launch on the Shuttle in July, to be attached to the FGB. However, due to the delay in the Shuttle launch of AXAF, Shuttle program managers have requested that NASA management explore the possibility of adjusting the current schedule of several flights in late FY 1998 and early FY1999, including the Neurolab and Node flights. This adjustment could better utilize the Shuttle work flow and processing capability, while not disrupting the overall Station assembly sequence. The desirability of maintaining a close interval between launch of the FGB and the Node may lead to evaluation of a similar shift in the FGB launch schedule. We will advise the Committee as our evaluation of optimization of Shuttle manifesting plans for the next year is completed.

A very complex piece of equipment, the Integrated Electronics Assembly, has also been delivered to KSC to begin outfitting with critical components of the power system. During the course of 1998, all of the flight hardware for the first six flights will be at Russian or American launch sites. To date, we have completed production of over 250,000 pounds of flight hardware, with 67% percent of program milestones completed.

Our Phase 1 Shuttle/Mir program has been a dramatic success. Andy Thomas is onboard the Mir as we speak; he is the seventh and last U.S. astronaut who will conduct long-duration research on Mir, continuing our 2.7 years of uninterrupted U.S. presence in space. This experience has taught us how to work across international boundaries on complex space operations, including on-orbit rendezvous and docking, rapid turnaround resupply, and on-orbit maintenance and repair. Our understanding of long-term space research has also improved with new appreciation in many areas, from physiological effects of the micro-g environment to crystal growth to space radiation effects on electronics. This new knowledge will carry forward to reduce risk and provide more proficient assembly and utilization of the International Space Station.

One major area of concern has been Russian performance on the Service Module. We are pleased to report remarkable progress since early 1997. A NASA/Boeing team has just returned from the Service Module General Designers Review in Russia and has confirmed that much has been completed. The Complex Stand test article electrical cable installation is complete with autonomous testing having been performed since November. Assembly Compartment and Working Compartment mating and Stage 2 of the electrical cable installation have been completed for the Service Module Flight Article. Lifetime testing on major components is progressing with no significant problems. We are very encouraged by this progress, and expect the Service Module launch schedule to be held to within two or three months of the planned launch date of December 1998. The Russians acknowledge that the Service Module is two months behind schedule, but that they have an ambitious plan for recovering those two months; as a result, they continue to hold to the December target. We believe their plan is very "success-oriented," and that it must proceed with little or no disruption in order to succeed. We will closely and carefully monitor the progress of its implementation. We will also monitor their progress in the integrated testing of their test article at the end of March; this will be a key indicator of any continued schedule risk.

Following the launch of the Service Module, a complex and critical part of the Station structure, the Z1 Truss, along with important guidance, communications and power system equipment, is to be launched in January 1999. Perhaps most importantly, however, plans call for the launching of the first International Space Station crew in just one year. We will remain focused to ensure that the spacecraft and support systems are ready for this critical milestone.

The U.S. Laboratory Module is currently two months behind schedule. As a part of an aggressive recovery plan, the Lab team continues to improve their performance in rack integration and module outfitting, but we are not yet back on track. Several key milestones in February and March will help us to more accurately gauge our schedule risk.

Software development and testing continues to be a challenging issue. The software development and testing schedules are tightly linked with the schedules for system and element level testing, operations planning and crew training. As difficulties develop in one area, a broad range of affected parties must tightly coordinate corrective actions to prevent the problem from developing into a schedule slip. We have instituted various review boards and an Integrated Problem Reporting System to ensure proper coordination.

We continue to hold adequacy of program reserves as a top program risk. With a program of such immense complexity, we expect to have additional unforeseeable technical issues. Consequently, NASA is seeking favorable consideration by the Congress in providing transfer authority for the remaining $200 million required for the International Space Station in FY 1998 in order to replenish our depleted near-term reserves in order to efficiently solve problems yet to occur in the coming year. Replenished outyear reserve levels for the Station program have been included in the revised outyear estimates for the International Space Station included in the President's FY 1999 budget request.

Space Shuttle

The FY 1999 budget request for the Space Shuttle program supports two major activities: Safety and Performance Upgrades ($571.6 million) and Space Shuttle Operations ($2.487 billion). Safety and Performance upgrades funding supports the modifications and improvements to the flight elements and ground facilities, which are expected to expand safety and operating margins, enhance Space Shuttle capabilities to meet customer requirements, and provide replacement of obsolete systems primarily through the Upgrades Program. In the past few weeks, two of our most critical Phase I upgrades have passed major milestones.

First, STS-89, our most recent Shuttle flight, was launched using the new large throat main combustion chamber in the Space Shuttle Main Engine which was designed to allow the engine to operate at a lower chamber pressure while maintaining performance. The lower chamber operating pressure reduces operating temperatures and pressures throughout the engine system, resulting in improved reliability and safety margins. The wider throat accommodates more cooling channels and an accompanying reduction in hot gas wall thickness, thereby increasing chamber life. This design is less labor intensive to produce and maintain. The performance of the new hardware was excellent during the flight. This new hardware will help to improve Shuttle safety, reliability and maintainability. Second, the first Super Lightweight Tank designed to support assembly of the International Space Station was officially certified for flight and rolled out of its assembly facility. The tank is 7500+ pounds lighter than its predecessor and will allow the Shuttle to carry heavy cargo to an orbital inclination of 51.6 degrees.

Shuttle Operation funding supports hardware production, ground processing, launch and landing, mission operations, flight crew operations, training, logistics, and sustaining engineering to maintain and operate the Shuttle fleet. The main operational contract, the Space Flight Operations Contract with United Space Alliance, successfully completed a first year of transition and consolidation while supporting eight missions in FY 1997. Phase II of the consolidation, began in FY1998 and will continue in FY 1999. Six Shuttle flights are manifested for FY 1998, including our first assembly flight of the International Space Station, a truly historic landmark. However, because of technical problems at the contractor facility, there is a possibility that the launch of AXAF could be delayed until early FY 1999. Space Station assembly will dominate FY 1999 with eight scheduled flights.

The Shuttle program will continue to focus on flying safely, supporting the manifest, improving support to our customers and reducing cost.

Life and Microgravity Sciences and Applications

NASA's Office of Life and Microgravity Sciences and Applications looks forward to important flight- and ground-based research opportunities in 1998 and 1999 which will prepare NASA and its research communities for the transition to research operations on the International Space Station. Laboratory research on Station will include biotechnology, biomedical research, combustion science, fluid physics, gravitational biology, and materials science. The Station will serve as a platform for Earth observation as well as for space physics research. It will support engineering research as well as testing and research for an array of advanced technologies in scientific, medical, and life support operations and engineering research. We are working to facilitate commercial participation in Station research to help to bring new findings and products to markets on Earth.

1998 will see the end of both the Shuttle/Mir program and the Shuttle/Spacelab combination. Each of these platforms has played a significant role in preparing NASA for research operations on the International Space Station. Fourteen years of Spacelab-based experience have identified the most promising fields of research, while operations on Mir have prepared us for long duration research aboard the Station.

Research highlights of the Shuttle/Mir missions include the first successful seed-to-seed-to-seed plant experiments in space; that is, two generations of plants were grown in the Mir greenhouse from seeds transported from the ground. New measurements were made of the change in position of the South Atlantic Anomaly, a location where the trapped radiation belts dip closest to Earth, related to long-term drift of Earth's magnetic field. Researchers demonstrated a new technique for protein crystal growth that produces many times more crystals per mission. Analysis and publications of results from Mir will continue through 1999. Over 15 research papers have been published to date; 30 are expected to be published by next year. An element of the final U.S. Shuttle mission to Mir in May 1998 is the Alpha Magnetic Spectrometer, a payload sponsored by the Department of Energy. Proposed by Nobel Laureate Dr. Sammuel Ting, the Alpha Magnetic Spectrometer will search for cosmic sources of antimatter and dark matter. Detection of either would have far-reaching research implications concerning the origin of the universe and the fundamental structure of matter itself. The Alpha Magnetic Spectrometer also will be deployed on the International Space Station for long term operations after the turn of the century.

This spring, NASA will launch Neurolab, the last scheduled Space Shuttle/Spacelab mission. Neurolab, NASA's contribution to the Federally designated Decade of the Brain, will expand our understanding of the nervous system by carrying out 26 experiments designed to study how the space environment affects the nervous system. Previous Space Shuttle missions have produced provocative results in the neurosciences, including the discovery that the structure of the balance system changes and adapts to reduced gravity. Space Shuttle findings also suggest that there is a critical period during which the presence of gravity is necessary if the nervous system is to develop normally in infant mammals. The peer review selection process for Neurolab was managed by the National Institutes of Health (NIH). Partners in the mission include the NIH, the National Science Foundation and the Office of Naval Research. International contributors include Canada, ESA, France, Germany, and Japan.

In order to ensure continued access to flight research during the assembly of the International Space Station, NASA has added dedicated Space Shuttle research flights for the U.S. and international life and microgravity research community in October 1998 and May 2000.

The 1998 mission, STS-95, will include a single SPACEHAB module in addition to payloads carried in the Shuttle middeck and payload bay. SPACEHAB has assumed responsibility for the integration and payload operations for the pressurized carrier volume and is responsible for marketing 45% of the available accommodations. Life and microgravity research on STS-95 will include biotechnology, biomedical, biological and fluid physics research. Biomedical research will include research on the aging process developed under a NASA-National Institute on Aging agreement. Associated with the flight of John Glenn on this mission, NASA is discussing with the National Institute on Aging how to maximize the scientific benefits of this unique opportunity. Both agencies would like to conduct parallel ground-based studies with aged subjects who remain on Earth but undergo comparable pre- and post-flight testing to the STS-95 crew. These control subjects will enrich this project and greatly facilitate comparisons of responses to space flight with normal aging on Earth.

The May 2000 mission, STS-107, is another mission of opportunity for multidisciplinary and internationally sponsored research. The carrier for this mission will consist of a double module developed by Spacehab especially for research purposes. The STS-95 approach will be used as a template for the management and operation. The HEDS Enterprise is currently developing the research themes for this mission; considerations are being given to peer-reviewed and commercially sponsored research in biotechnology, materials sciences, biology and biomedicine. NASA will continue to seek partnership with NIH, NSF and other organizations in accomplishing this research.

In 1998 and 1999, NASA will expand its ground-based research program on the biological effects of space radiation. The radiation environment in space is substantially different from the radiation environment on Earth, and its biological effects are not well understood. Investigations will continue using proton and high-energy ion beams, including research using facilities at Loma Linda University and Brookhaven National Laboratory. This research focuses on the mechanisms by which space radiation modifies cells and tissues to become cancerous. Some of this work is sponsored jointly with the National Cancer Institute. A new collaborative effort will begin with the Space Flight and Space Science Programs to include radiation and soil/dust measuring devices on robotic missions to Mars beginning in 2001.

The newly established National Space Biomedical Research Institute will select its first research proposals in 1998 and complete a plan for developing advanced countermeasures for controlling the effects of space flight. Working with the Johnson Space Center, the National Space Biomedical Research Institute (NSBRI) has begun a process to define the critical elements necessary to develop and validate procedures to assure crew health in orbit and on return to Earth. These procedures will be defined in 1998 and implemented in 1999 so that they will be fully functional by the time of International Space Station operations.

NASA conducts its research activities in close cooperation with commercial, academic, and government researchers. With the launch of the first elements of the International Space Station this year, our primary research focus will be to prepare this diverse community for efficient and effective operations using the Station's expanded laboratory research capabilities.

Space Science

NASA's Space Science Program is a shining example of the new way of thinking at the Agency. In the last few years, we have removed billions of dollars from planned spending and have reengineered all aspects of how we do business. Expensive missions are a thing of the past. The size, complexity and cost of spacecraft missions have been reduced significantly, while increasing or maintaining their scientific capability.

NASA's Space Science Enterprise has embraced the philosophy of "faster, better, cheaper," and the results have been dramatic. The average development time for Space Science missions in 1990-94 was 8.1 years; it is now about 4 years, and we expect the decline to continue. The average spacecraft development cost at the beginning of the decade was $553 million -- compared to the current level of $165 million, and the projected 2004 level of $50-$75 million. In the early 90's, the Space Science Program averaged 1.8 launches a year. This year, we have 10 launches planned, the first of which -- Lunar Prospector -- lifted off flawlessly in January and is beginning its year-long, in-depth study of our Moon.

Perhaps nothing in recent memory embodies the concept of "doing more with less" better than last year's dramatic July 4 landing of Pathfinder on Mars. After more than 20 years, we returned to the Red Planet. Once again, we captured the world's attention, but this time we did it for a total cost of $266 million and with an operational staff of 50. That is NASA's new way of doing business.

And by no means was Mars Space Science's only success story. Discoveries from the Hubble Space Telescope, Galileo, the Compton Gamma Ray Observatory, and the Solar and Heliospheric Observatory (SOHO) -- to name just a few -- are broadening our understanding of the Universe and our place within the cosmos. For example, Hubble uncovered over 1,000 bright, young star clusters bursting into life in a brief, intense, brilliant "fireworks show" at the heart of a nearby pair of colliding galaxies. Galileo sent a probe into the heart of Jupiter and returned amazing pictures of icebergs on Europa, suggesting the possibility of hidden, subsurface oceans.

The Near-Earth Asteroid Rendezvous spacecraft gave us our first up-close look at Asteroid 253 Mathilde, which scientists believe dates back to the beginnings of the Solar System. Also in 1997, we realized the long-awaited launch of NASA's last "big" planetary mission, Cassini/Huygens. Cassini, along with its ESA-built Huygens probe, is on a 7-year journey to study Saturn, its moons, and its rings. Scientists using the NASA-ESA SOHO mission have discovered "jet streams" of hot, electrically-charged plasma flowing beneath the surface of the Sun. These new findings should help scientists understand the famous 11-year Sunspot cycle and associated increases in solar activity that can disrupt the Earth's power and communications systems. Astronomers using NASA's Rossi X-ray Timing Explorer spacecraft have observed a black hole that is literally dragging space and time around itself as it rotates. This bizarre effect, called "frame dragging," is the first evidence to support a prediction made in 1918 using Einstein's theory of relativity.

These successful Space Science missions are having an immense impact being felt not only in college lecture halls, but also in newspapers, on television, and in the textbooks of tomorrow. We are heightening the sense of accomplishment and adventure that is a hallmark of our Nation's Space Science program.

As NASA approaches its 40th birthday, it is an inspiration to look back and marvel at all we have learned in the area of Space Science. What lies ahead in the next 40 years and beyond are detailed studies of the various mysteries we have so far uncovered. A new, interdisciplinary approach has been developed to make the next great strides possible. In Space Science, we have identified four basic themes around which we will operate and organize ourselves. The four science themes are: Sun-Earth Connection, Exploration of the Solar System, Structure and Evolution of the Universe, and Astronomical Search for Origins. In addition, the Origins and Distribution of Life in the Universe is a fifth theme which cuts across the other four.

The President's proposed Space Science budget for FY 1999 of $2.058 billion supports a strong and well balanced program that will enable continued study of the Sun, the Solar System, and the Universe. It maintains support for the Origins Initiative approved by Congress in the FY 1998 budget to search for planets around other stars, to study galaxies as they are born, and to look for evidence of life elsewhere in the Solar System and the Universe. It adds funding to fulfill much of the promise of the new Space Science Strategic Plan with new initiatives to investigate the evolution and destiny of the Universe, complementing those in the Origins initiative that was begun last year. Some examples of programs in the new initiatives are: continuing the ISTP missions through Solar Maximum in order to obtain a comprehensive set of data throughout the 11-year solar cycle; continuing Solar-Terrestrial Probes after TIMED, with Solar B and Solar Stereo as the next two missions; joining with ESA on the FIRST mission to observe the Universe in the far-infrared and submillimeter region of the spectrum; building GLAST, a follow-on to the Compton Gamma Ray Observatory to observe the highest-energy objects in the Universe; and initiating a program to develop technology for the next X-ray mission that would follow AXAF. These efforts support a balanced program addressing each of the four quests identified in the Space Science Strategic Plan: Solving Cosmic Mysteries, Exploring the Solar System, Searching for Extrasolar Planets, and Searching for Life Beyond Earth.

Through continued exploration, NASA's Space Science Enterprise brings the benefits of Space Science to the American public and to the worldwide scientific community. The primary products of Space Science are knowledge and discoveries about the Universe in which we live. The process by which we acquire knowledge and make discoveries is through exploration. Whether physical, using space probes and planetary landers and orbiters, or remote, using telescopes and other observatories, our exploration will continue opening the frontier of space in exciting and productive ways. Our goal is to make the wonders of the Universe accessible and relevant for all Americans.

Earth Science

This is an exciting year for the Earth Science Enterprise, formerly known as Mission to Planet Earth, because we begin the Earth Observing System or "EOS" era. With launches of EOS-AM-1 and Landsat-7, we will begin to collect the necessary data to answer many critical questions about the Earth. We will launch the QuikScat mission in late 1998, using a "faster, better, cheaper" development approach to replace valuable ocean winds data set lost with the failure of Japan's ADEOS spacecraft. With EOS, we seek to understand how land and coastal regions are changing over time, how to forecast precipitation a year in advance, how to determine the probabilities of floods and droughts, how to predict changes in the Earth's climate a decade to a century in advance, and monitoring ozone depletion to determine if efforts to control harmful chemicals are effective.

The President's budget request for Earth Science for FY 1999, $1.372 billion, will also enable the Earth Science Enterprise to increase research funding for our Commercial Remote Sensing program, and restore research grant funding to a healthy level. We will endeavor to form an industry-Government collaboration on a low-cost, high-performance radar mission that will produce quality science data, to enhance understanding of floods, earthquakes, and sea level rise while at the same time contributing to valuable applications such as managing forests, measuring soil moisture, and finding potential oil and coal reserves.

Looking beyond FY 1999, we are developing a series of light-weight, low-cost science missions, Earth System Science Pathfinders, the first of which will examine and model terrestrial ecosystems and the second which will study ocean currents, ocean heat transport, and the varying size of ice sheets. We are also demonstrating next-generation technologies as part of NASA's New Millennium Program, a series of small, rapid development missions to flight test promising new instruments. For the first mission, which is scheduled to fly next year, we are developing an advanced land imager and for the second mission we will demonstrate technology to improve weather forecasting abilities.

The success of these small missions is part of the new paradigm of the Earth Science Program, which focuses on front-end technology development investments that will lead to smaller, lighter, and less costly missions which will not compromise the program if a satellite is lost. Another component of this paradigm involves a "catalogue" of procurements of commercial spacecraft buses which will lead to lower costs and quicker development. We are in the process of redefining later Earth Science missions based on this new paradigm: our scientists and technologists are working side-by-side to provide the science we need using the latest technology.

While we look forward to the future of NASA's Earth Science Program, we are producing valuable data today. While the effects of El Niño are apparent to us all, we need to recognize the valuable role that a joint NASA-French satellite (TOPEX/Poseidon) is playing in the monitoring of the warm water mass in the tropical Pacific six months before it began to affect the weather of the Americas. We launched a joint mission with the Japanese (TRMM) a few months ago to make precise measurements of rainfall in the tropics, which is critical in the understanding of the Earth's climate. Also last year, a private company launched a satellite to provide scientific data on life in the oceans which NASA will purchase from them—data which this company will also sell to the fishing, oil, and shipping industries.

The critical system required to capture the raw data from these missions, process it into geophysical parameters for scientific research, and provide the necessary distribution and archival functions, is the EOS Data and Information System (EOSDIS). Central to the development of this system is the development of the scientific algorithms to enable the conversion of the raw data into geophysical parameters. The development and delivery of these algorithms is on-track, as is the calibration/validation effort that supports it. EOSDIS itself will be ready to provide the launch critical functions for the upcoming launches of EOS AM-1 and Landsat-7. The science data processing aspects of this system are being developed in increments, allowing us to better determine the performance of our contractors, while also obtaining the approval of the scientific users along the way. At the same time, we are opening up the future implementation of this system to innovative thinking from experts within NASA, academia, and industry across the country. In this way, the American people can be assured that we get the maximum use possible from the data to be provided from these groundbreaking missions.

In addition to the great science, the Earth Science program is providing direct, practical benefits to the American people. Farmers and commodity traders are able to detect healthy vegetation based on a continuously updated "green report." NASA data is also being used to demonstrate the beneficial effects of urban forests which lessen the impact of "urban heat islands," bubble-like accumulations of hot air, that have developed as cities have grown during the past 20 years. Sport and commercial fishing fleets are using NASA data to more efficiently locate areas with the best fishing potential, such as locations with certain temperatures and water clarity characteristics.

With the help from NASA science data, solar power is being provided cheaply and efficiently for people of the world without electricity who may spend the entire day searching for fuel. In 1996, 88,000 wildfires burned over 6 million acres at a cost of over $1 billion in fire control activities. NASA data has been used to develop a series of fire potential maps in the western U.S. to assist firefighters in fire planning and assessment. Municipalities across the country will soon be able to manage their tax mapping and building permit process by comparing current digital aerial photography and high resolution satellite imagery with that from prior years, using sophisticated computer "change detection" software. NASA data is also being used to create "Nowcast" weather forecasts to assist drilling in the Gulf of Mexico. Drilling activities cannot proceed in currents stronger than 2 knots, because of the difficulty in dynamic position-keeping as well as the stresses imposed on the drill itself as it extends through the water column. Accurate, localized weather forecasting reduces the cost of drilling operations.

But this is just the beginning of a growing commercial remote sensing industry that will grow and mature in the next century. Earth Science data from future NASA missions will not only allow us to answer critical questions such as climate change and natural hazards, but will also spur the development of commercial uses of scientific data. This data will assist farmers in measuring crop yields and assessing soil conditions. Foresters will be able to measure timber health and assess fire hazards. The fishing industry will be able to monitor ocean winds and determine ocean plant and sediment concentrations. Insurers will be able to assess damage caused by floods, droughts, landslides, and beach erosion as well as use improved weather forecasting to mitigate damage.

While these applications provide great benefits, the primary mission of the Earth Science Enterprise is the collection and analysis of scientific data concerning the Earth. With the start of the EOS era, we will begin to more comprehensively address critical questions about the Earth that will benefit us all.

Aeronautics and Space Transportation Technology

NASA's Aeronautics and Space Transportation Technology Enterprise is revolutionizing the science and technology that sustain global U.S. leadership in civil aeronautics and space transportation. Our program is focused on three "Pillars" for success -- Global Civil Aviation, Revolutionary Technology Leaps, and Access to Space -- and a set of ten enabling technology goals to address current and future National needs. By developing pre-competitive, long-term, high technical risk technologies, we contribute to market growth, safety, increasing air system capacity, consumer affordability, environmental compatibility, and opening new opportunities in space. Because our work must be transferred to industry and other Government agencies to meet these National goals, we work in close partnership with these groups in formulating and implementing our programs. The Enterprise includes three major program areas: aeronautics, space transportation technology and commercial technology. The President's budget request for Aeronautics and Space Transportation Technology for FY 1999 of $1.305 billion will enable us to aggressively pursue our technology goals in space and aeronautics.

The **Aeronautics** program focuses on the long-term safety, efficiency, and environmental compatibility of aircraft and the systems in which they operate. The High-Speed Research (HSR) program, a key contributor to "Revolutionary Technology Leaps," is making tremendous progress in addressing the high-risk, make-or-break environmental and economic "barrier issues" associated with any future High Speed Civil Transport (HSCT). Successful U.S. leadership in this next-century market could mean a difference of $200 billion in sales and 140,000 high-quality jobs for domestic aircraft manufacturers. In 1997, we completed initial External Vision System flight tests, including 90 approaches and landings in day and night on the NASA 737 research vehicle. These tests are important in developing future synthetic vision technologies for pilots so that a future HSCT would not require a drooped nose such as today's Concorde. Synthetic vision technologies may also have a safety benefit to subsonic commercial pilots by providing additional visibility in adverse weather, and may find application in a future reusable launch vehicle. In another advance, HSR researchers fabricated advanced titanium 4 and 5 sheet Superplastic Forming and Diffusion Bonding panels. If this technology is applied to a future HSCT, it will dramatically reduce aircraft weight, increasing performance and affordability.

Building on the successful results in the existing HSR program, we are proposing an extension beyond Phase II, Phase IIA. Beginning in FY 1999, HSR Phase IIA will focus on answering some of the remaining technology questions for a viable, economical and environmentally sound HSCT. Our first priority is propulsion, but as our confidence grows in that area, we will pursue additional airframe work as well.

We have restructured the Advanced Subsonic Technology (AST) program in order to aggressively address the goals of the "Global Civil Aviation" and "Revolutionary Technology Leaps" pillars. We have realigned the previous eight program elements into five: safety; environment; capacity; affordability; and general aviation. By working in partnership with the FAA and the U.S. aeronautics industry, we ensure that the high-payoff technologies we develop will enable a safe, highly productive global air transportation system that includes a new generation of environmentally compatible, operationally efficient U.S. subsonic aircraft. In 1997, we successfully demonstrated cockpit systems for landing and aircraft rollout and taxiing at Atlanta Hartsfield Airport. These systems aid pilots in viewing the runway and taxiways during night or adverse weather, improving airport safety and capacity. We also tested advanced fuel injectors, which in laboratory tests demonstrate a greater than 70% reduction in nitrogen oxide pollutants. Other tests showed three-decibel fan and jet noise reduction and a 25% nacelle acoustic liner improvement; combined with additional NASA research in airframe noise reduction these advances may result in future technologies that could reduce perceived noise levels at the nation's busiest airports by 50%.

NASA is an integral part of the multi-agency Large-Scale Networking and High-End Computing and Computation (LSNHECC) program, aiming to boost supercomputer speeds one thousand-fold to at least one trillion arithmetic operations per second -- one teraflop -- and communications capabilities one hundred-fold. As part of this program, NASA is one of several agencies making contributions to the Next Generation Internet (NGI). NGI allows NASA essentially to "live in the future" in emerging applications such as advanced aerospace design and test, telemedicine, earth sciences, astrobiology, astrophysics and space exploration. This effort is also funded in the Space Science, Earth Science and Education programs.

We continue to nurture the Aeronautics Research and Technology (R&T) Base, which is the vital foundation of expertise and facilities that meets a wide range of aeronautical technology challenges. By providing a high-technology, diverse-discipline environment, we enable the development of new, even revolutionary, aerospace concepts and methodologies for applications in industry. Work within the R&T Base lays the foundation for future focused programs to address the long term goals of the Enterprise's three pillars. For example, in FY 1998 and FY 1999, NASA's efforts to achieve the goals of the Administration's Aviation Safety Initiative are supported from reinvestments made within the R&T Base. We anticipate that in FY 2000, as technologies for safety advance, a new focused program for safety will emerge. We are doing exciting things in the R&T Base.

In 1997, NASA's solar-powered aircraft Pathfinder set an altitude record for propeller-driven flight of over 71,500 feet. This type of technology will enable high-altitude, long-endurance for affordable, unpiloted science missions. Also in 1997, we successfully completed a critical design review of the Hyper-X launch vehicle, which will begin flight testing in January, 2000 and is the essential next-step for airbreathing hypersonic flight.

The **Advanced Space Transportation Technology** program supports our "Access to Space" pillar. Our goal is to completely revitalize access to space by reducing launch costs dramatically over the next decade, increasing the safety and reliability of current and next generation launch vehicles, and establishing new plateaus of performance for in-space propulsion while reducing cost and weight.

NASA is taking the lead in developing the technology for next generation reusable space transportation systems. The FY 1999 Reusable Launch Vehicle (RLV) Program includes both ground-based technology development and flight demonstrators -- the X-34 small reusable demonstrator and the X-33 large-scale Advanced Technology Demonstrator. Each portion of this program contributes to the process of validating key component technologies, proving that the technologies can be integrated into a functional vehicle, and demonstrating the required operability to make low-cost access to space a reality. We are requesting funds to initiate the Future-X "Pathfinder" flight experiments for demonstrations of technologies which can further reduce the cost and increase the reliability of reusable space launch and orbital transportation systems.

The Advanced Space Transportation Program (ASTP) focuses on technological advances with the potential to reduce costs beyond RLV goals, as well as technology development required to support NASA strategic needs not addressed by RLV. The ASTP includes a base of technology investments which, like the Aeronautics R&T Base, lays the foundation for future focused programs. Each element of the ASTP addresses a recognized need for near- and long-term reductions in space transportation costs by taking bold steps forward in innovative technologies and vehicle configurations. The Advanced Space Transportation Program also includes funding for industry-led trade studies of options for the next-generation launch decision at the end of the decade. We want smart people outside the Agency to help us make the right decision, because America's future in space is at stake.

An important part of the Aeronautics and Space Transportation Technology Enterprise is the **Commercial Technology** program. Since its inception in 1958, NASA has been charged with ensuring that NASA-developed technology is transferred to the U.S. industrial community to improve its competitive position in the world community. Our commercialization effort encompasses all technologies created at NASA centers by civil servants as well as innovations from NASA contractors. The technology commercialization program consists of conducting a continuous inventory of newly developed NASA technologies, maintaining a searchable database of this inventory, assessing the commercial value of each technology, establishing R&D partnerships with industry for dual use of the technology, disseminating knowledge of these NASA technology opportunities to the private sector, and supporting an efficient system for licensing NASA technologies to private companies. The amount requested for NASA commercialization efforts includes $100 million to carry out the provisions of the Small Business Innovation Research (SBIR) Act, which requires a set-aside of 2.5% of NASA's total extramural R&D spending for small business research grants, along with an additional set-aside for the Small Business Technology Transfer (STTR) Program of 0.15% of NASA's total extramural R&D spending. The NASA SBIR program has contributed to the U.S. economy by fostering the establishment and growth of over 1,100 small, high technology businesses.

Taken together, this Enterprise provides powerful fuel for advances in aeronautics and space transportation, leading the Nation in a position of strength into the next century.

Conclusion

Mr. Chairman, this year we will all have the opportunity to stand together as proud Americans, along with our Russian, Japanese, European, and Canadian friends, as the conceivers and managers of the largest international science and technology program ever attempted, and look into the night sky at a tiny speck of light streaking from west to east at some 17,000 miles per hour. This will be the awesome sight of the first elements of the International Space Station. I look forward to that night as I hope you do.

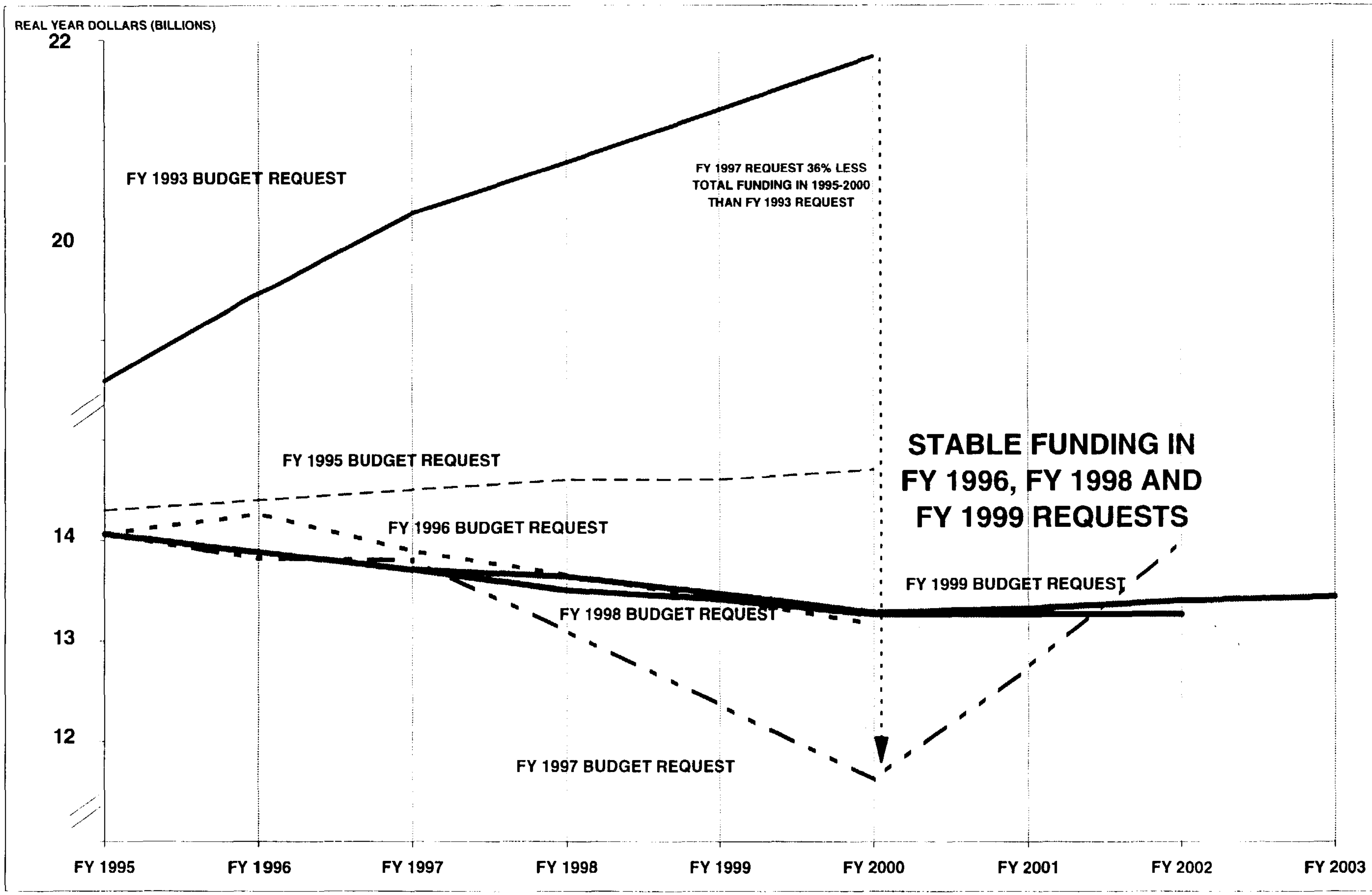
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1999 ESTIMATES
(IN MILLIONS OF REAL YEAR DOLLARS)

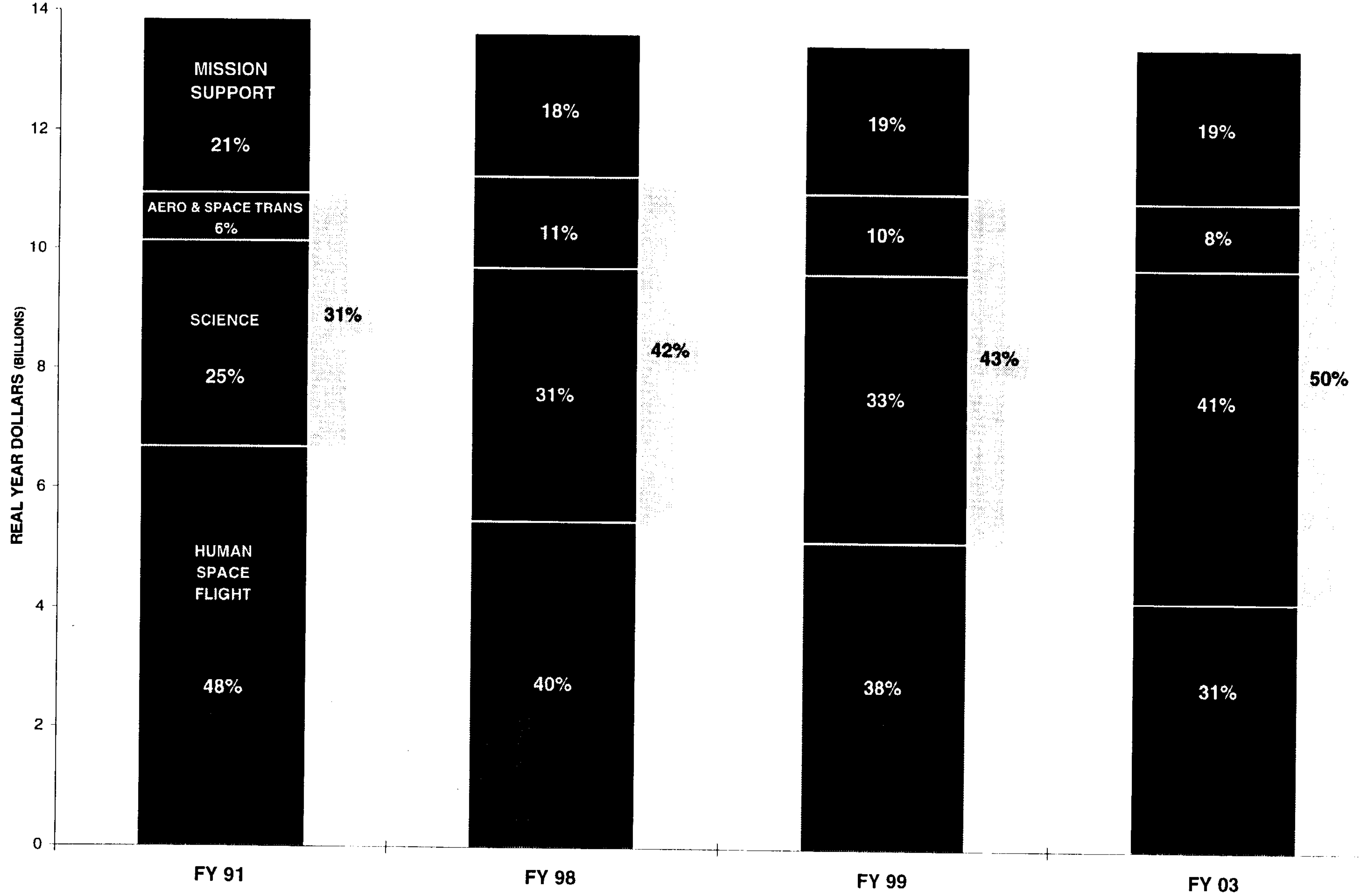
The FY 1999 multi-year budget estimate is submitted in accordance with the NASA FY 1989 Authorization Law (P.L. 100 685).

	1997 PAST YEAR	1998 CURRENT YEAR	1999 BUDGET YEAR	2000	2001	2002	2003
HUMAN SPACE FLIGHT	**5,674.8**	**5,679.5**	**5,511.0**	**5,312.0**	**5,156.0**	**4,930.0**	**4,715.0**
SPACE STATION	2,148.6	2,501.3	2,270.0	2,134.0	1,933.0	1,766.0	1,546.0
US/RUSSIAN COOPERATIVE PROGRAM	300.0	50.0					
SPACE SHUTTLE	2,960.9	2,922.8	3,059.0	2,998.0	3,049.0	2,989.0	2,989.0
PAYLOAD UTILIZATION AND OPERATIONS	265.3	205.4	182.0	180.0	174.0	175.0	180.0
SCIENCE, AERONAUTICS AND TECHNOLOGY	**5,453.1**	**5,552.0**	**5,457.4**	**5,530.4**	**5,726.4**	**5,917.4**	**6,120.4**
SPACE SCIENCE	1,969.3	1,983.8	2,058.4	2,207.4	2,308.4	2,387.4	2,568.4
LIFE AND MICROGRAVITY SCIENCES AND APPLICATIONS	243.7	214.2	242.0	257.0	266.0	264.0	264.0
EARTH SCIENCE	1,361.6	1,367.3	1,372.0	1,492.0	1,494.0	1,449.0	1,407.0
AERONAUTICS & SPACE TRANSPORTATION TECHNOLOGY	1,339.5	1,470.9	1,305.0	1,092.0	1,026.0	1,057.0	1,071.0
MISSION COMMUNICATION SERVICES	418.6	395.8	380.0	382.0	382.0	380.0	380.0
ACADEMIC PROGRAMS	120.4	120.0	100.0	100.0	100.0	100.0	100.0
FUTURE PLANNING (SPACE LAUNCH)					150.0	280.0	330.0
MISSION SUPPORT	**2,564.0**	**2,388.2**	**2,476.6**	**2,415.6**	**2,412.6**	**2,526.6**	**2,579.6**
SAFETY, MISSION ASSURANCE, ENGINEERING AND ADVANCED CONCEPTS	38.8	37.8	35.6	35.6	35.6	39.6	39.6
SPACE COMMUNICATION SERVICES	291.4	194.2	177.0	136.0	125.0	151.0	121.0
RESEARCH AND PROGRAM MANAGEMENT	2,078.5	2,033.8	2,099.0	2,079.0	2,087.0	2,171.0	2,254.0
CONSTRUCTION OF FACILITIES	155.3	122.4	165.0	165.0	165.0	165.0	165.0
INSPECTOR GENERAL	**16.8**	**18.3**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**
TOTAL	**13,708.7**	**13,638.0**	**13,465.0**	**13,278.0**	**13,315.0**	**13,394.0**	**13,435.0**

FY 1999 PRESIDENT'S BUDGET

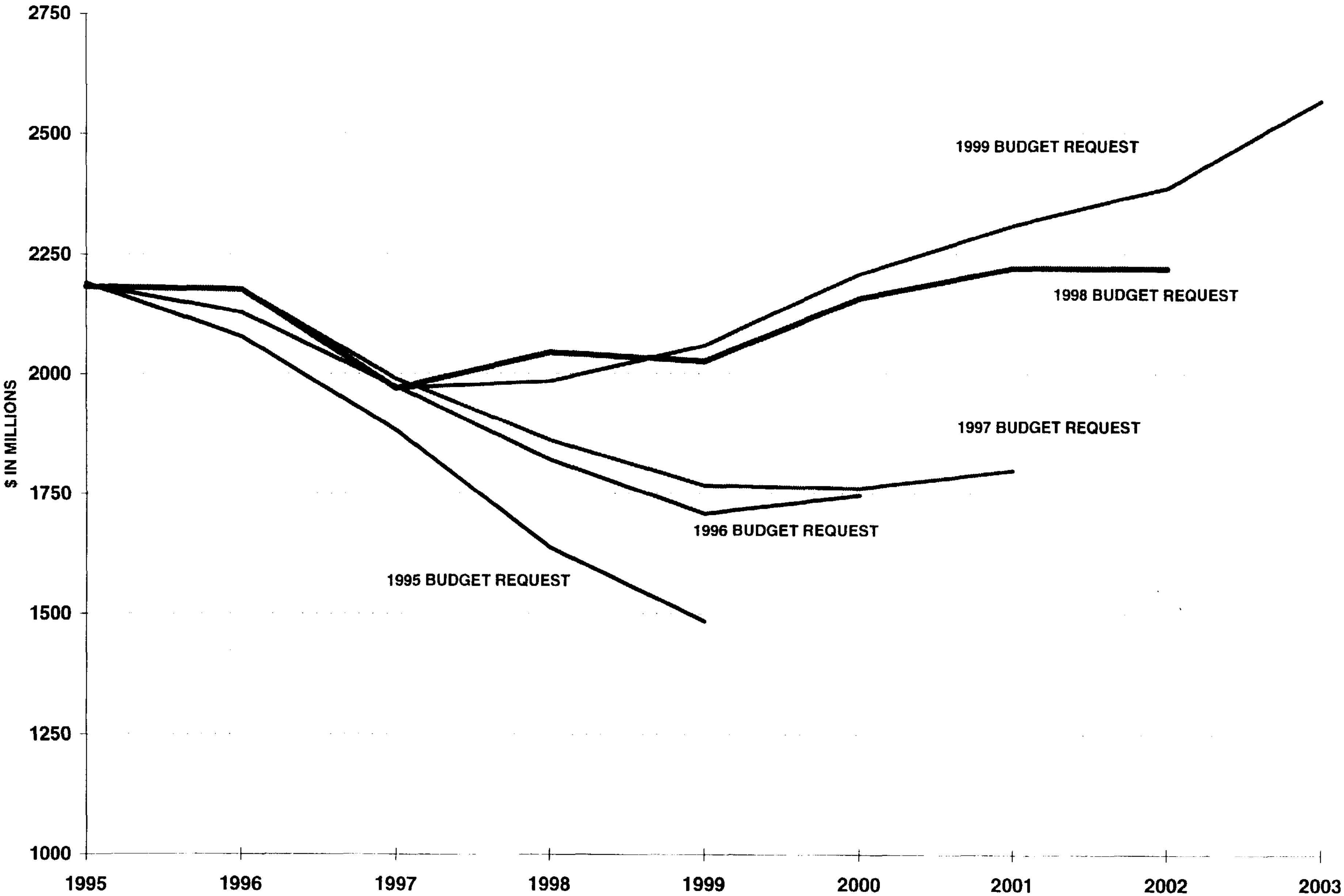


FY 1999 BUDGET



FY 1999 BUDGET

SPACE SCIENCE BUDGET REQUESTS *



* FY 95-97 REQUESTS ADJUSTED TO REFLECT TRANSFERS OF ELV, HPCC AND CROSSCUTTING TECHNOLOGY PROGRAMS TO OSS BUDGET

NASA Restructuring Progress

FY 1993 - FY 2000

	THEN - FY 1993	DECEMBER 1997	FUTURE - FY 2000
Civil Serv.:	24,900	19,187	17,818
Supv Ratio:	5.4:1	9.6:1	11:1
HQs Staff:	2,200	1,022	954
*SSC:	1,344	610	600

23% Reduction

7% Reduction

WHAT: **STREAMLINING PLAN**

TOOLS:

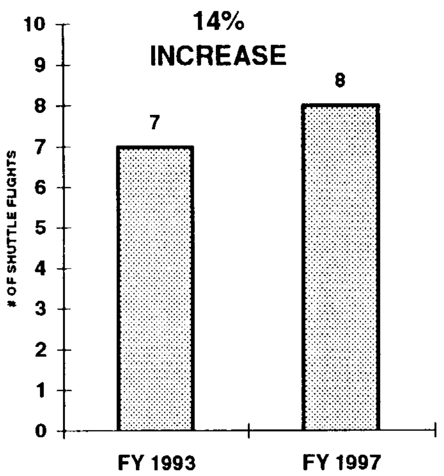
FY 1993 - December 1997	December 1997 - FY 2000
Buyouts;	Buyouts;
Hiring Freeze;	Consolidation;
Restructure;	Privatization;
Redeployment	Outplacement;
	Redeployment;

Does not include the NASA Office of Inspector General

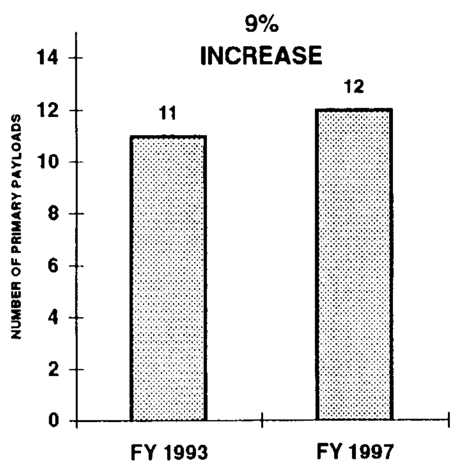
Figure 1

SHUTTLE DELIVERING MORE FOR THE MONEY

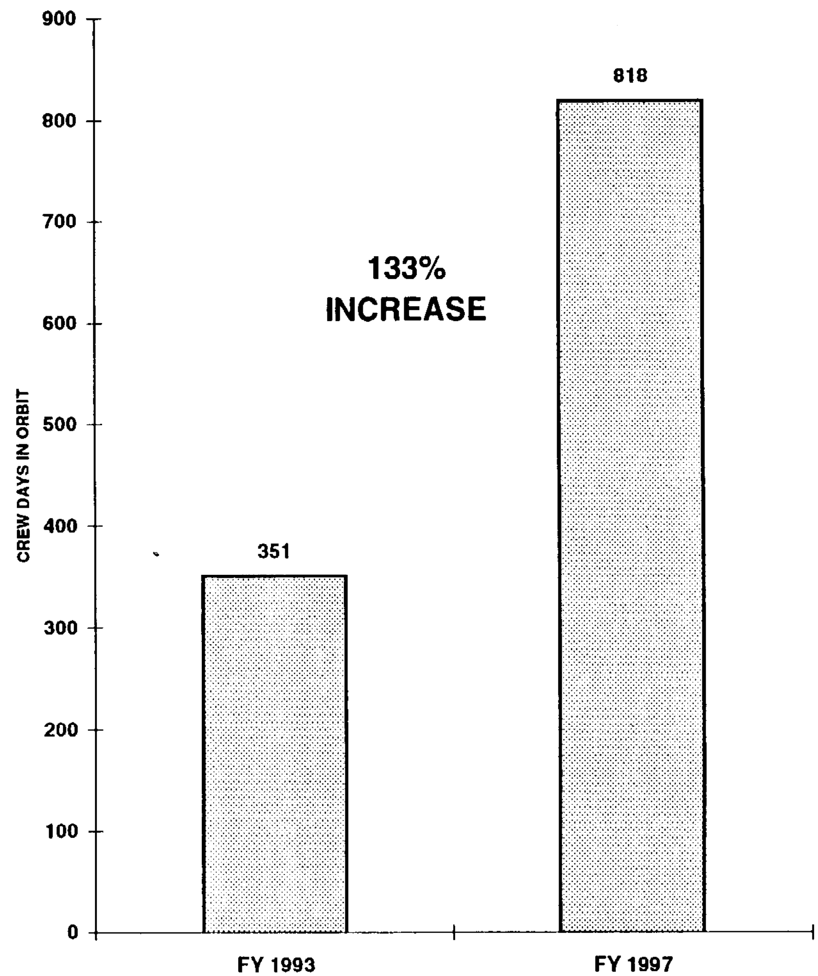
NUMBER OF FLIGHTS



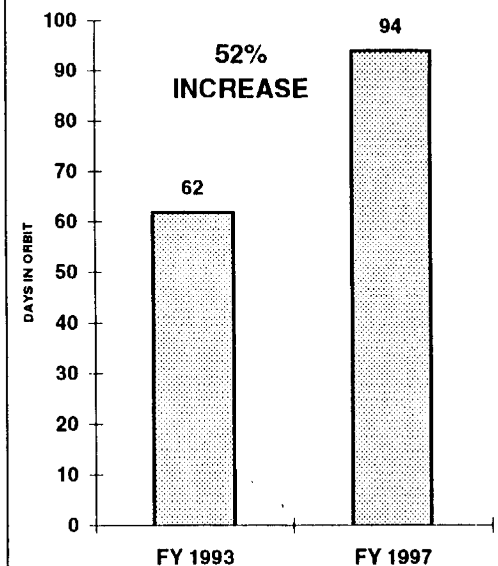
PRIMARY PAYLOADS



CREW DAYS IN ORBIT *

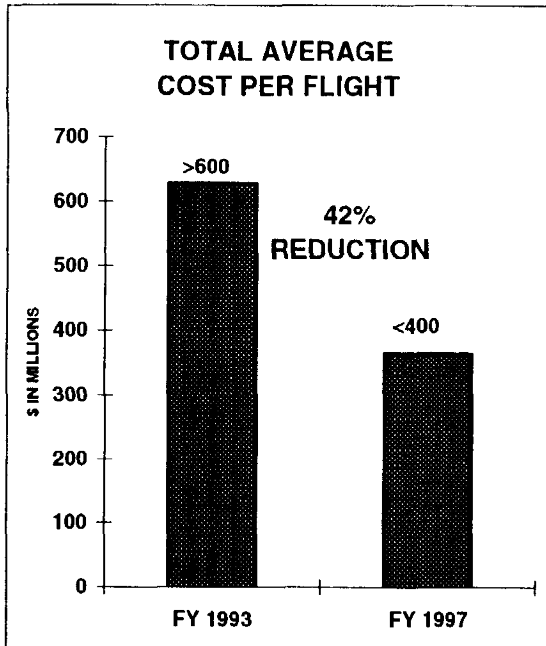


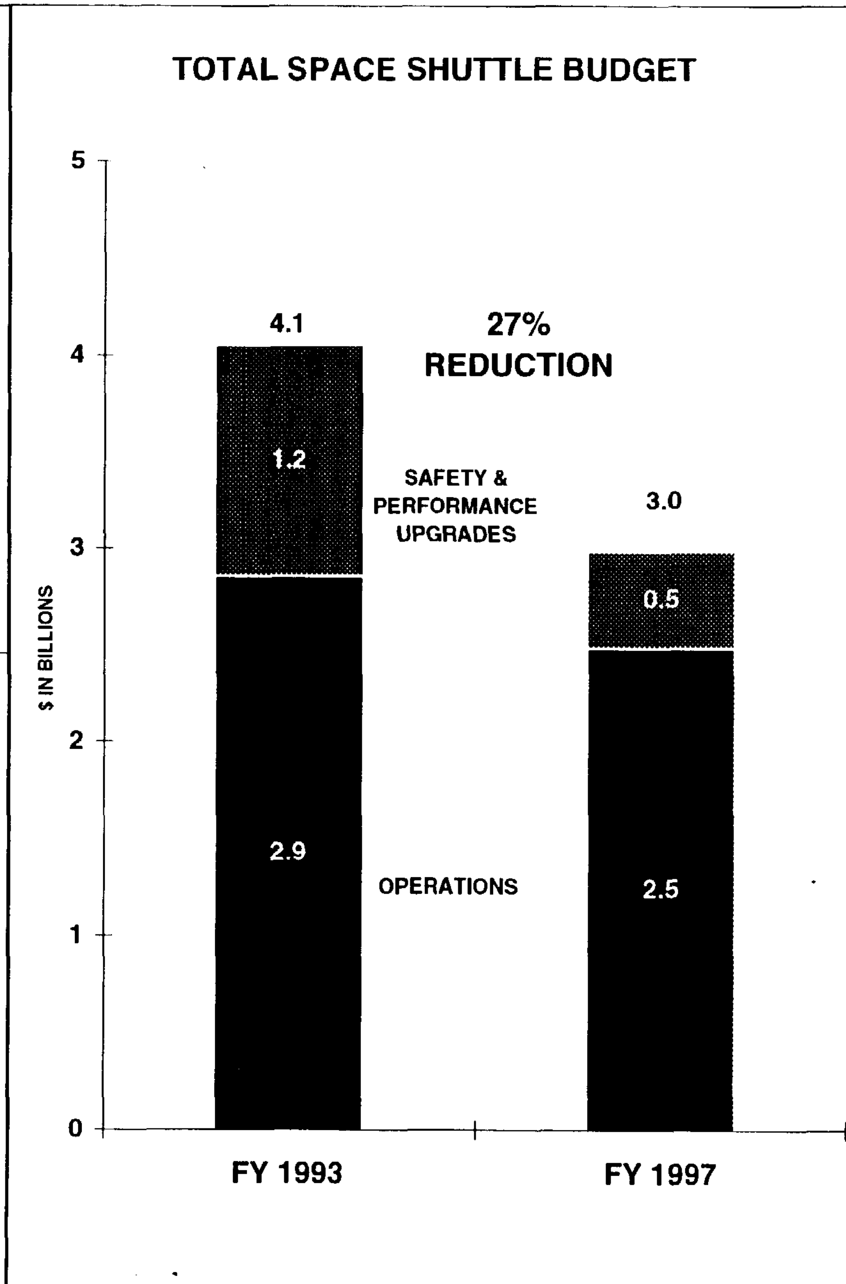
DAYS IN ORBIT

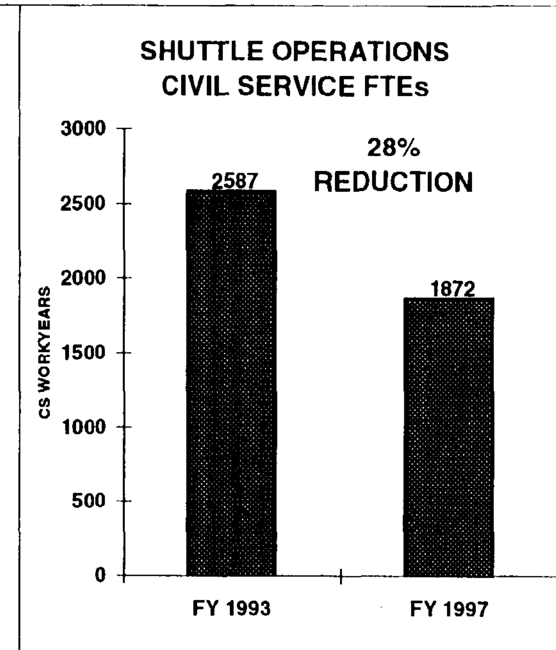


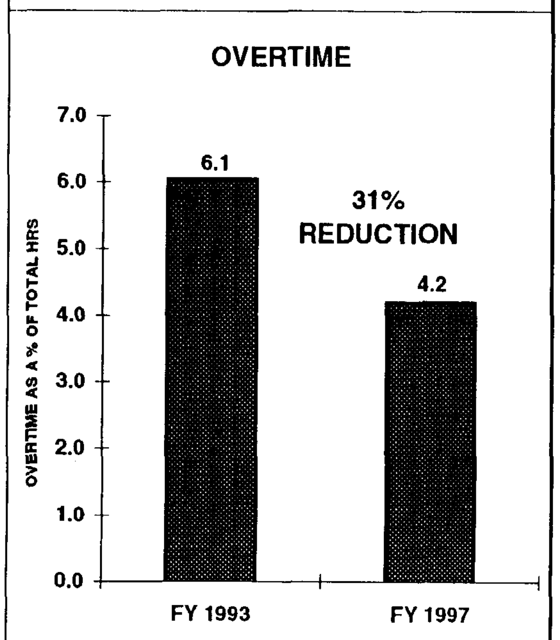
* Crew Days on Orbit includes 390 crew days on Mir in FY 97

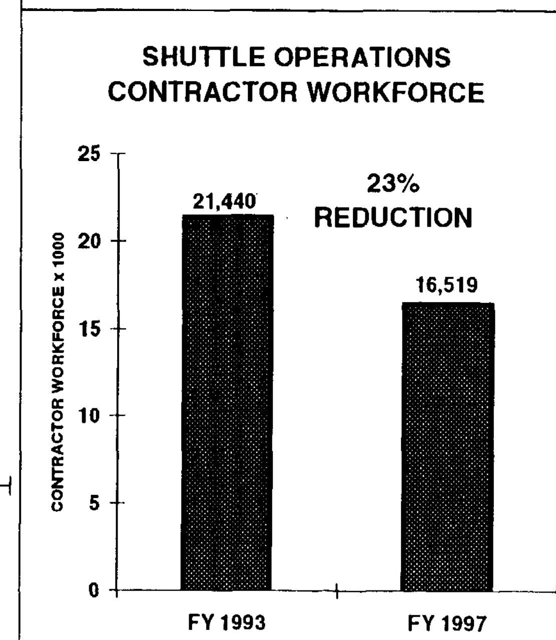
GREATLY REDUCED SHUTTLE COST











SIGNIFICANT SHUTTLE SAFETY IMPROVEMENTS